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UNITED STATES GOVERNMENT  
memorandum

7103/147  
DATE: 4 December 1996

FROM: Burton G. Hurdle (Code 7103)

SUBJECT: REVIEW OF REF. (a) FOR DECLASSIFICATION

TO: Code 1221.1

VIA: Code 7100

REF: (a) NRL Confidential Report #1605 by L.C. Ricalzone, 7 Apr 1965

1. Reference (a) discusses proposed experiments to integrate the Loreli technique in the DASH attack system using the AN/SQS-26 and a smaller ship for the transponder, in place of a helicopter.
2. The technology and equipment of reference (a) have long been superseded. The current value of this report is historical.
3. Based on the above, it is recommended that reference (a) be declassified and released with no restrictions.

  
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CONCUR:

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Superintendent  
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**Some Proposed Experiments Toward  
Improving the Dash-Loreli Technique**  
[Unclassified Title]

L. C. RICALZONE

*Sound Division*

April 7, 1965



U.S. NAVAL RESEARCH LABORATORY  
Washington, D.C.

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ED BY: ~~DDC~~

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**CONTENTS**

Abstract	11
Problem Status	11
Authorization	11
BACKGROUND	1
PURPOSE	1
Experiments to be Conducted	2
CONCLUSIONS	4
REFERENCES	5
Figure 1	6
Figure 2	7
Figure 3	8
Figure 4	9

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**ABSTRACT  
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Considerable interest has been shown in using the LORELI Technique to improve the DASH weapons system and some exercises have been conducted on one possible method of applying LORELI to DASH. This method is not considered the most desirable by NRL because it does not make use of the true LORELI Technique. Several experiments are proposed in this report to determine the feasibility of using the true LORELI Technique in the DASH system. Also, a method is proposed for investigating the effect of multipaths on the LORELI Technique used over the bottom bounce and convergence zone propagation paths in order to design optimum displays and transponder buoys.

**PROBLEM STATUS**

This is an interim report on one phase of the LORELI problem and work in this area is continuing.

**AUTHORIZATION**

NRL Problem 55S02-09  
NUOS Project Order No. 4-0190

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**SOME PROPOSED EXPERIMENTS TOWARD  
IMPROVING THE DASH-LORELI TECHNIQUE**

**BACKGROUND**

Present ASW attack systems depend on the absolute accuracy of the sonar target range and bearing. This accuracy suffers from equipment and alignment errors in the sonar, and from acoustic path anomalies. These errors can be tolerated at the short sonar ranges but at the longer ranges possible with the AN/SQS-26 and sonars of the future these errors may well place the weapons outside of their acquisition capabilities or lethal radius, especially over the bottom bounce or convergence zone paths where the exact acoustic path is unknown. A review of the literature on range and bearing errors in present fleet sonars show that bearing errors of 2° and range error of 2 1/2%, reference (a), are about the best that can be expected. Range error as high as 8% reference (b), are common. Medium errors up to 5° reference (c) due to horizontal gradient and to internal waves have been reported. Even the specified required range and bearing accuracy of 1% and 1° reference (b), will place many weapons outside their effective range even if the assumption is made that no other errors exist at convergence zone ranges.

Work on the LORELI Technique has shown that a significant improvement can be made in the overall accuracy of ASW attack systems at long ranges. In work done at ranges up to 20,000 yards it has been shown, references (d) and (e), that the overall attack error can be considerably less than the accuracy demanded from the sonar. This improvement can be made with simple fire control equipment.

**PURPOSE**

The purpose of this report is to describe a number of simple experiments which should be conducted that could lead to a much improved DASH-LORELI technique at the longer ranges. Two types of experiments are proposed: one type to develop techniques for vehicle guidance and the second type to study the effect of multipaths on the accuracy of LORELI in the bottom bounce and convergence zone modes.

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Limited evaluation of one possible method of using LORELI with DASH was conducted by OPTEVFOR and NUOS with disappointing results because of hardware and other problems, reference (f). This method consisted of marking the position of the DASH vehicle on the radar display and position of the transponder buoy on the sonar display at the time of transponder buoy drop. This method does not use the true LORELI technique and suffers from several inaccuracies. It is believed that two other approaches could lead to considerably better results. One of these is to put an effective radar reflector or radar transponder in or attached to the same buoy as the sonar transponder. The other is to physically attach the sonar transponder to the drone by a long cable and to dunk the transponder at intervals to obtain the exact position of the drone with respect to the target using sonar alone. Both of these approaches have hardware and operational problems which would have to be solved before an effective operational technique can be developed. However, simple experiments can be run with existing equipment to determine if sufficient gain in accuracy would be achieved by these techniques to warrant the time and cost of the hardware and operational developments. Also experiments can be conducted with existing equipment and laboratory equipment under development to determine the effect of multipaths on the LORELI technique in the bottom bounce and convergence zone modes. From this experiment valuable information would be obtained which would aid in the development of displays and transponder buoys to be used with the LORELI technique in propagation modes where multipaths exist.

Experiments to be Conducted

An experiment to investigate the case of using a transponder with an adequate radar reflector will require the following services: A ship equipped with AN/SQS-26 or AN/SQS-23 sonar, operating in an area capable of at least 10 and preferably 20 kiloyard sonar ranges, will be needed as the echo-ranging vessel. Either a DASH vehicle or a manned helicopter such as an HUL will be used as the attacker. A small ship to simulate an effective radar reflector with a sonar transponder suspended under it will be used as the LORELI transponder. A second sonar transponder launched and retrieved by this ship will be used for the target. The operation will be set up as follows: The ship acting as the transponder buoy

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will place the target transponder in the water and then stand off 500 to 1000 yards. The echo-ranging ship will move out to near maximum sonar range, establish sonar contact, and position the helicopter over the ship by means of radar. Using the sonar vector for ship to target, the helicopter will be controlled again by radar to the target position and a marker buoy to simulate a weapon dropped. The small ship will then assess the "miss distance". Twenty or so runs of this type should yield valuable insight to the effectiveness of this technique. A number of straight DASH runs can be conducted for comparison.

The second experiment will require the same services and equipment as in the preceding one. In this experiment the sonar transponder is attached to a manned helicopter such as an HUL by a cable. A small ship with a sonar transponder suspended under it will act as the target and the NRL acoustic DME reference (g), installed on this ship could be used to measure the miss distance. The transponder suspended from the helicopter will be an AN/SQQ-18 modified with tail fins and a tow point as shown in Figure 1. Figures 1, 2, and 3 show this configuration towed from a small boat up to a speed of 10 knots. It proved very stable and presented little drag. This means that in operation the helicopter need not make a good hover but can have a speed of up to about 10 knots. In operations the helicopter will be vectored by radar out to the vicinity of the target where it is commanded to hover with the transponder in the water. With the sonar vector information from the transponder to the target as displayed on the sonar of the echo-ranging ship, the helicopter is commanded to climb and pick the transponder out of the water and is then vectored by radar control to the target, dropping the simulated weapon (DME buoy) on command for miss distance measurement. If desired, the helicopter could be commanded to dunk the transponder several times on the way to the weapon drop point in order that corrections could be made to the attack vector. Approximately the same number of runs should be made as in the first exercise.

All of the equipment needed for these experiments is presently available. The operation is not complicated

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and it should be able to be conducted in a matter of several days, assuming good sonar conditions to yield the desired ranges. Valuable data can be obtained from these two exercises which will assist in determining if further effort and funds should be expended on these two approaches to the DASH-LORELI technique.

Basic experiments to investigate the effect of multipaths on the LORELI technique need to be made for the bottom bounce and convergence zone propagation modes. These tests will require the use of an AN/SQS-26 equipped ship for echo-ranging and a smaller ship to carry a special instrumented transponder as shown in the block diagram, Figure 4. This transponder is now being developed by NRL. It will measure accurately the time of arrival and intensity of the various multipaths seen by a transponder at various depths. It will return a signal at known level of controlled characteristics after triggering by desired path. It will measure propagation loss from the SQS-26 sonar to the transponder directly. Also, the propagation loss of return path, and signal-to-noise or reverberation ratios can be measured by the addition of a recorder to the sonar. From this transponder the characteristics for an expendable LORELI transponder, which will operate properly in the presence of multipaths, can be determined. This experiment will also determine if the SQS-26 displays are suitable for LORELI operation, or if not, what types of displays need be developed for LORELI operation in the presence of multipaths. This data will be valuable for the DASH-LORELI case as well as other LORELI techniques operating over the bottom bounce and convergence zone paths.

## CONCLUSIONS

It is felt that the experiments described in this report can be run with a minimum of fleet services and would yield valuable information on DASH-LORELI techniques and on the difficulties that might be encountered in the use of LORELI under multipath conditions. Also, data would be obtained which would be useful in modifying or developing transponders and displays for use under these conditions. The key item to the satisfactory completion of these tests is adequate services of an SQS-26 equipped ship and adequate funding of the LORELI Program.

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**REFERENCES**

- (a) CNO Secret TAAG Monograph No. TC-1 "Sonar Detection Probability and Accuracy", Nov. 1963
- (b) Human Factors Research Inc. Technical Report 206-24, "The Effect of Calibration Accuracy of Basic Sonar Operations"
- (c) Combat Readiness Vol. X, No. 3, "Submarines are not for Killing", LCDR Sullivan
- (d) NRL Report 5631 "LORELI Technique"
- (e) NRL Report 6247 "Toward the Elimination of Ocean Environment Variations in Integrated Detection Localization and Attack Systems" (Conf)
- (f) COMOPTEVFOR Conf ltr FF5-7/422:klm 393/ca22 Ser 0163 of 5 Mar 1964
- (g) NRL Report 5955, "Underwater Acoustic Distance Measuring Equipment" (DME) (C) May 28, 1963

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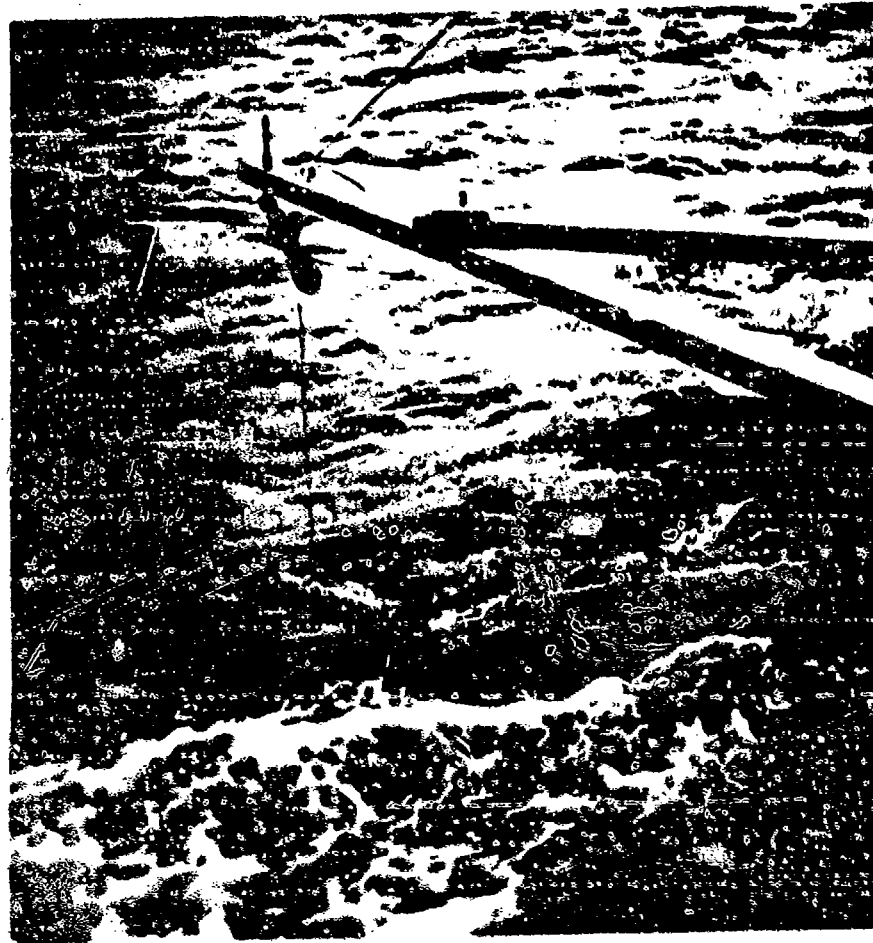


Fig. 1 - AN/SQQ-18 transponder buoy  
modified for towing

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Fig. 2 - AN/SQQ-18 transponder buoy under  
tow near the surface



Fig. 3 - AN/SQQ-18 transponder buoy under tow



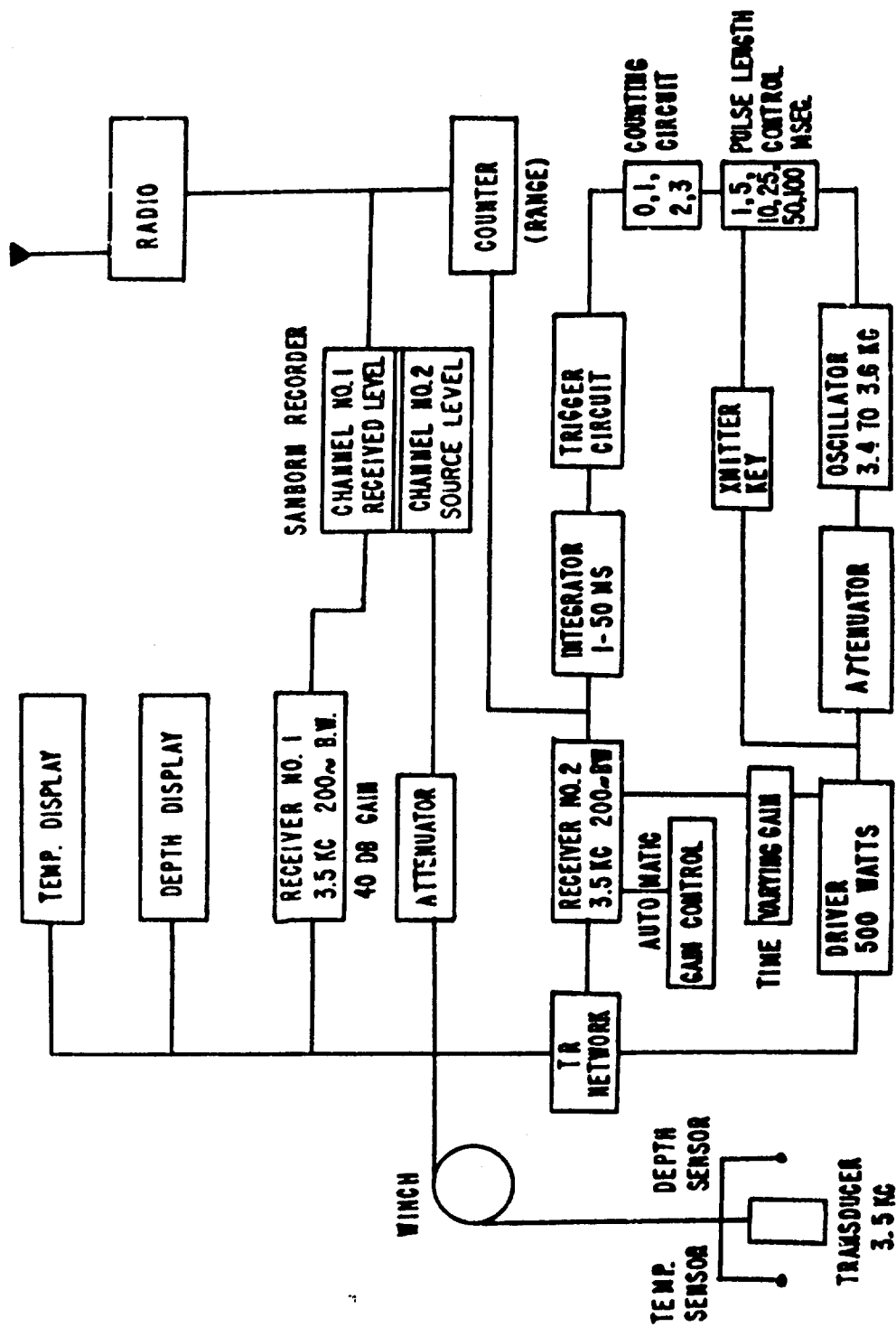


Fig. 4 - Experimental transponder for use with AN/SQS-26